SFD Report

Shivaraj Municipality
Nepal

Final Report

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SFD Report Shivaraj Municipality, Nepal, 2024

Produced by:
Asmita Shrestha, ENPHO
Jagam Shrestha, ENPHO
Buddha Bajracharya, ENPHO
Rupak Shrestha, ENPHO
Anita Bhuju, ENPHO
Sabuna Gamal, ENPHO

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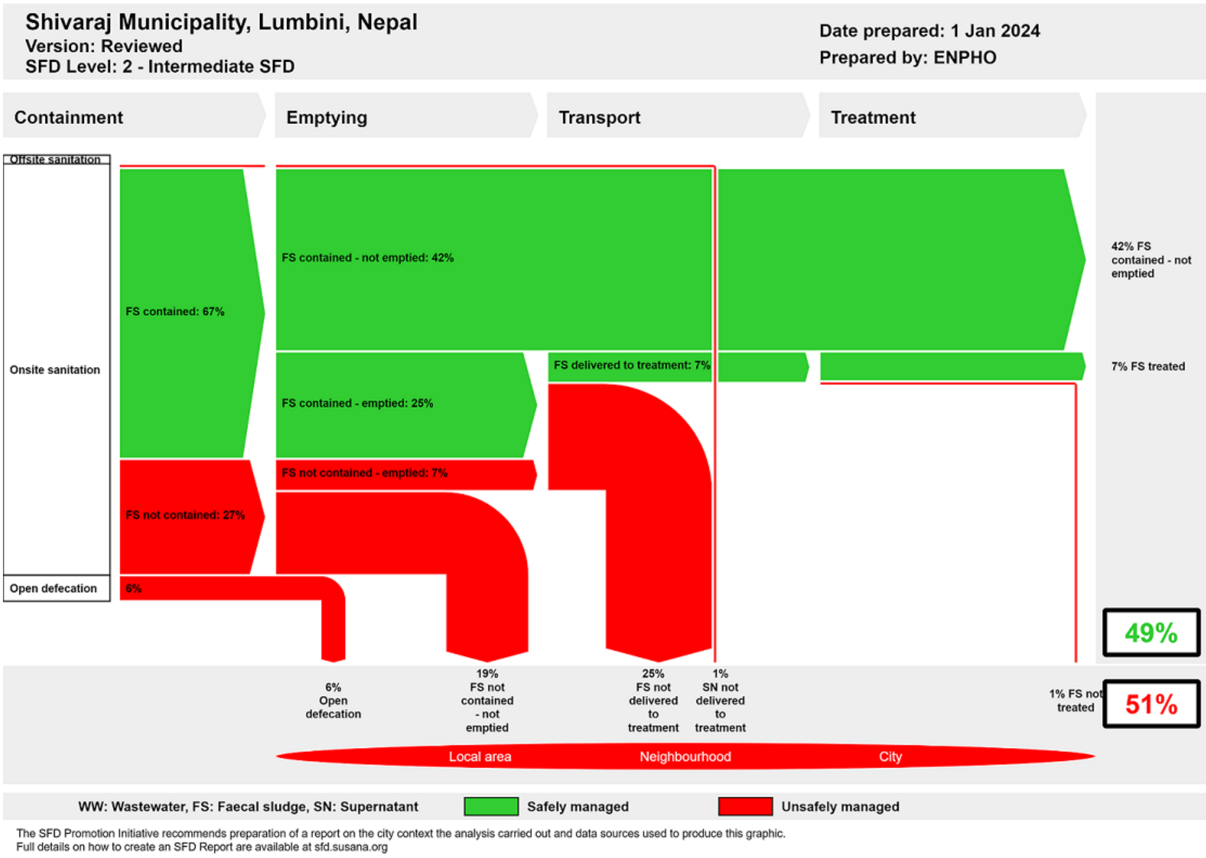
1. The SFD Graphic



2. Diagram information

SFD Level:

This SFD is a level 2 - Intermediate report.

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3. General city information

Shivaraj Municipality, established in 2014 through the merger of eight Village Development Committees (VDCs) in the Kapilvastu district, Nepal, encompasses 248.08 square kilometres.

The 2021 census reports a population of 84,810 in 16,241 households, with a gender distribution of 51.3% male and 48.7% female.

The climate mirrors Lumbini's, with an annual temperature of 29.73ºC and distinct wet and dry seasons. The municipality lies at an altitude of 700-1,000 metres, featuring flat terrain with some fragmented areas and a chure hill.

4. Service outcomes

This section provides a quick summary of the various sanitation technologies used across the municipality's sanitation value chain. All data in this section are from the household and institutional surveys conducted for this study (ENPHO, 2023).

Containment:

In Shivaraj Municipality, despite 94% of households having access to improved sanitation facilities, 6% still practice open defecation. The municipality relies solely on onsite sanitation systems, with the distribution of safe systems including septic tanks (3%), biogas digesters (9%), fully lined tanks (38%), twin pits (12%), lined tanks with impermeable walls and open bottoms (4%), and single offset pits (28%).

Emptying and transportation:

Emptying is crucial, and 39% of households emptied their containment due to sludge overflow. Of the total emptied containments, 84% were mechanically emptied by private desludging vehicles, while 16% underwent manual emptying, with sludge disposal in farmlands or dumping. Within the municipality, the cost differs as per private desludgers, even on-demand services are being provided beyond the municipality.

The municipality lacks a faecal sludge treatment plant, and private desludgers exhibit diverse disposal practices, including illegal dumping into water bodies or open places, disposing in confined land and farmlands. Institutional buildings in the municipality predominantly use lined tanks, with approximately 33% of institutions having undergone mechanical desludging at least once.

The survey in Shivaraj Municipality indicates that the majority (82.93%) of households rely on groundwater sources for drinking water, with 13.6% having private or yard taps and 0.27% using public or community taps and 3.20% depend on jar water. Key Informant Interview (KII) with Water Sanitation and User Committees (WSUC) revealed that Chandrauta WSUC is serving in Ward 5 and Shivgadi WSUC in Ward 9, providing water services to over 1,500 and 650 households respectively. The primary water source for these committees is boring water from depths of 400-500 feet (121.9m - 152.4m), with limited chlorine treatment.

Groundwater pollution risk assessment considers factors like the source of drinking water, aquifer vulnerability, and water quality tests. MICS data shows 82.6% faecal contamination in source water, and local tests found *E. coli* in handpump sources below 100 feet (30.4m). Containment systems like lined tanks with open bottoms and lined pits with semi-permeable walls are identified as potential contributors to aquifer pollution. Users relying on such systems and consuming water within specified depth and distance parameters are assumed to face significant groundwater pollution risk.

The SFD graphic shows that 49% of the excreta or faecal sludge generated are safely managed while 51% are unsafely managed. The safely managed Faecal Sludge (FS) generated by 42% of the population is temporary as this FS is only contained. So, once the containment gets filled and the FS from the containment is emptied, the percentage of unsafely managed FS would increase.

5. Service delivery context

Access to drinking water and sanitation has been defined as fundamental rights to every citizen by the constitution of Nepal. To respect, protect and implement the rights of citizen embedded in the constitution, the Government of Nepal (GoN) has endorsed the Water Supply and Sanitation Act 2022 which has emphasized on a right to quality sanitation services and prohibited direct discharge of wastewater and sewage into water bodies or public places.

Several policies have been in place to accomplish the sanitation need of people. Particularly, the National Sanitation and Hygiene Master Plan (NSHMP) 2011 has proved as an important strategic document for all stakeholders to develop uniform programs and implementation mechanism at all levels. It strengthens institutional set up with the formation of water and sanitation coordination committee at every tier of government to actively engage in sanitation campaigns.

6. Overview of stakeholders

Based on the regulatory framework for Faecal Sludge Management (FSM), the major stakeholders for effective and sustaining service delivery as presented in Table 1.

Table 1: Overview of Stakeholders.

Key Stakeholders	Institutions / Organizations
Public Institutions at Federal Government	Ministry of Water Supply
Public Institutions at Provincial Government	Ministry of Water Supply, Rural and Urban Development
Public Institutions at Local Government	Shivaraj Municipality, Chandrauta WSUC, Shivgadi WSUC
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Private Sector	Public toilet operators, Private desludgers
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Credibility of data

The major data were collected from proportionate stratification random sampling. Altogether, 375 households and 81 institutions were surveyed from 11 wards of the municipality. Primary data on emptying, transportation, and current sanitation practices in the municipality are validated from Key Informant Interviews (KIIs) with private desludgers, water service providers, public toilet caretaker and other different sanitation and environmental stakeholder. The overall data and findings were shared with the stakeholders of the municipality and validated through a sharing program on 6th December, 2023.

8. Process of SFD development

Data on sanitation situation is collected through household and institutional surveys (ENPHO, 2023). Enumerators from the municipality were mobilized after providing orientation on sanitation technologies, objectives of the survey and proper use of mobile application, KOBOCOLLECT for collection of data for survey. Along with this, KIIs were conducted with officers and engineer of municipality city and private desludging service providers to understand the situation practices across the service chain. Types of sanitation technologies used in different locations were mapped using ARCGIS. To produce the SFD graphic, initially a relationship between sanitation technology used in questionnaire survey and SFD PI methodology was made. Then, data were fed into SFD graphic generator to produce the SFD graphic.

9. List of data sources

The list of data sources to produce this executive summary is as follows:

- CBS. (2020). Multiple Indicator Cluster Survey, 2019. Kathmandu, Nepal: Central Bureau of Statistics.
- ENPHO. (2023). Sanitation Survey on Shivaraj Municipality. Shivaraj.
- NSO. (2022). National population and housing census 2021. Kathmandu: National Statisitics Office.

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Sabuna Gamal, ENPHO

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Abbreviations

BMGF	Bill and Melinda Gates Foundation
DWSSM	Department of Water Supply and Sewerage Management
ENPHO	Environment and Public Health Organization
E.coli	Escherichia coli
FS	Faecal Sludge
FSM	Faecal Sludge Management
FSTP	Faecal Sludge Treatment Plant
GON	Government of Nepal
HH	Household
IRF	Institutional and Regulatory Framework
KII	Key Informant Interview
KM	Kilometre
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
MoUD	Ministry of Urban Development
MuNASS-II	Municipalities Advocacy on Sanitation in South Asia – II
NGO	Non-Governmental Organization
NWSC	Nepal Water Supply Corporation
NSHMP	Nepal Sanitation and Hygiene Master Plan
NUWSSSP	National Urban Water Supply and Sanitation Sector Policy
NWSSP	National Water Supply and Sanitation Policy
ODF	Open Defecation Free
RWSSNP	Rural Water Supply and Sanitation National Policy
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SFD	Shit Flow Diagram
SFD PI	Shit Flow Diagram Promotion Initiative
UCLG ASPAC	United Cities and Local Governments Asia Pacific
UNICEF	United Nations Children's Education Fund
UCLG ASPAC	United Cities Local Government – Asia Pacific
VDC	Village Development Committee
WASH	Water Sanitation and Hygiene
WHO	World Health Organization
WSSDO	Water Supply and Sanitation Divisional Office
WSUC	Water and Sanitation Supply and User's Committee
WW	Wastewater

1. City context

Shivaraj Municipality is located in the Kapilvastu district, Lumbini province of Nepal. It was established on 28 April, 2014 (2071-01-15 B.S) by merging the eight existing Village Development Committees (VDCs): Shivapur, Birpur, Chhanaie, Bishanpur, Jawabhari, Shivagadi, Thunihiya, and Lalpur (Shivaraj Municipality, 2021). The municipality covers an area of 248.08 square kilometres and is bounded on the east by Bhuddhabhumi Municipality, on the west by Bijayanagar rural Municipality, on the north by Argakhanchi and Dang district, on the south by Maharajgunj and Krishnanagar Municipality. The central hub of the municipality is Chandrauta bazaar (Municipality, 2076). The map below shows the ward boundary of Shivaraj Municipality.

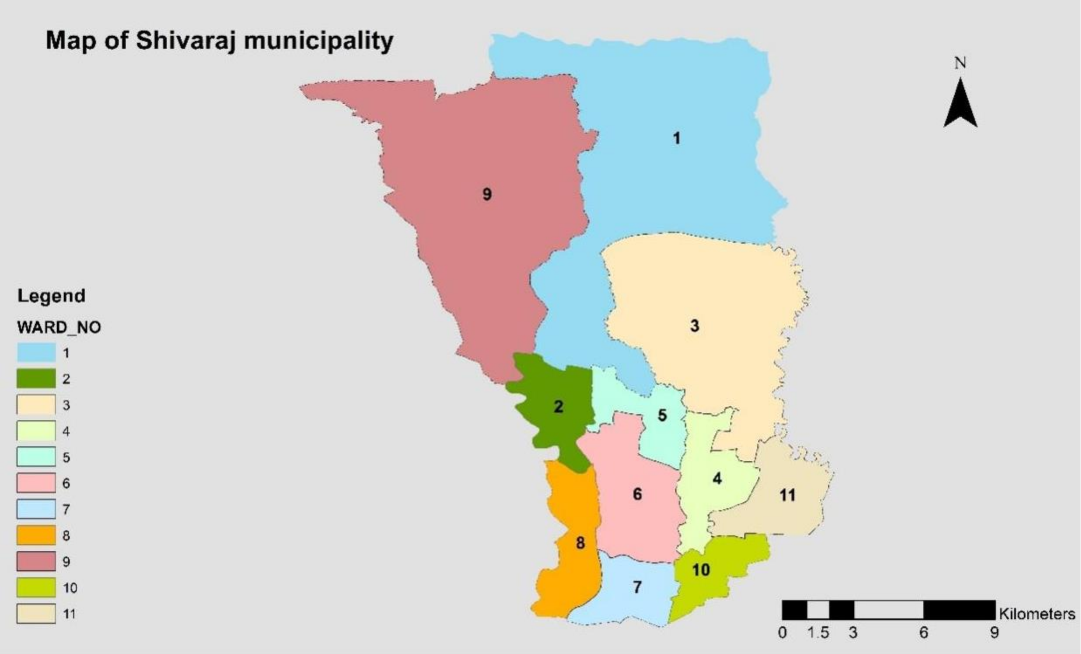

Figure 1: Map of Shivaraj Municipality with ward boundaries.

1.1 Population

As of the 2021 National Population and Housing Census, the municipality has a total population of 84,810 living in 16,241 households. The gender distribution reveals that 51.3% are male and 48.7% are female. The population density in the municipality is 399, with a sex ratio of 95.05 males per female (NSO, 2021). Ward 5 being central hub of municipality has the highest population while ward 7 has the least population.

1.2 Climate

The municipality shares a climate similar to that of Lumbini. Shivaraj Municipality experiences a humid subtropical, dry winter climate. The city's average annual temperature is 29.73ºC (85.51ºF) with the warmest month being May (40.13ºC / 104.23ºF) and driest month November (1.45mm / 0.06in). Similarly, the wettest month is July (508.01mm / 20.0in) and coldest month is January (14.39ºC / 57.9ºF) (Cwa category). Throughout the year, the region receives an average precipitation of 106.2mm (4.18 inch) (Weather and climate, n.d.).

1.3 Topography

Shivaraj Municipality is situated between latitudes of 27°34'6" to 27°47'44" north and between longitudes of 82°43'4952" to 82°56'7" east (Municipality, Shivaraj, 2076). Situated at an altitude of 700-1,000 metres above sea level, the majority of the municipality's terrain is flat, with some areas featuring a fragmented landscape due to the rivers and streams. Additionally, there is a chure hill located in the upper part of municipality on both the right and left side of the East West highway, approximately 50 kilometres away from the district headquarter, Taulihawa Municipality (Municipality , 2076).

2. Service Outcomes

2.1 Overview

The country has persistently worked towards achieving its current sanitation status for over three decades. On September 30, 2019, the Government of Nepal declared the nation free of open defecation, marking universal access to improved sanitation facilities nationwide (DWSS, 2019). However, municipality's municipal reports in 2019 A.D (2076 B.S) revealed that 11% of households still lack access to basic sanitation facilities, and 44.76% have access to improved sanitation facilities (Municipality , 2076).

Data on sanitation situation were collected through household and institutional surveys (ENPHO, 2023). As per the findings of this household survey, despite municipality making significant progress, with 94% of households now having access to improved sanitation facilities, 6% still resort to open defecation (ENPHO, 2023). To assess the sanitation status across the entire sanitation value chain, a household survey was conducted in 375 sampled households using a proportionate sampling across the 11 wards of Shivaraj Municipality (further details are presented in section 4). The results obtained after the triangulation and validation of the data with all the data sources including literature reviews, Key Informant Interviews (KIIs) and a validation workshop is presented in this section.

2.1.1 Sanitation System in Households of Shivaraj Municipality

An improved sanitation facility is defined as one that hygienically separates human excreta from human contact. Improved sanitation facilities include flush or pour flush to piped sewer systems, septic tanks or pit latrines, ventilated improved pit latrines, pit latrines with slabs and composting toilets (MICS, 2019).

Currently, the municipality does not practice any offsite sanitation systems. Instead, all households rely on onsite sanitation systems to contain Faecal Sludge (FS) produced at the household level in the municipality (ENPHO, 2023).

Of the total 375 sampled households, 94% of the population had access to improved sanitation facilities where all relied on onsite sanitation system and 6% of the households are still practising open defecation. The blue circle in map shows the onsite sanitation system and red triangle shows the area locating open defecation practice within the Shivaraj Municipality (Figure 2).

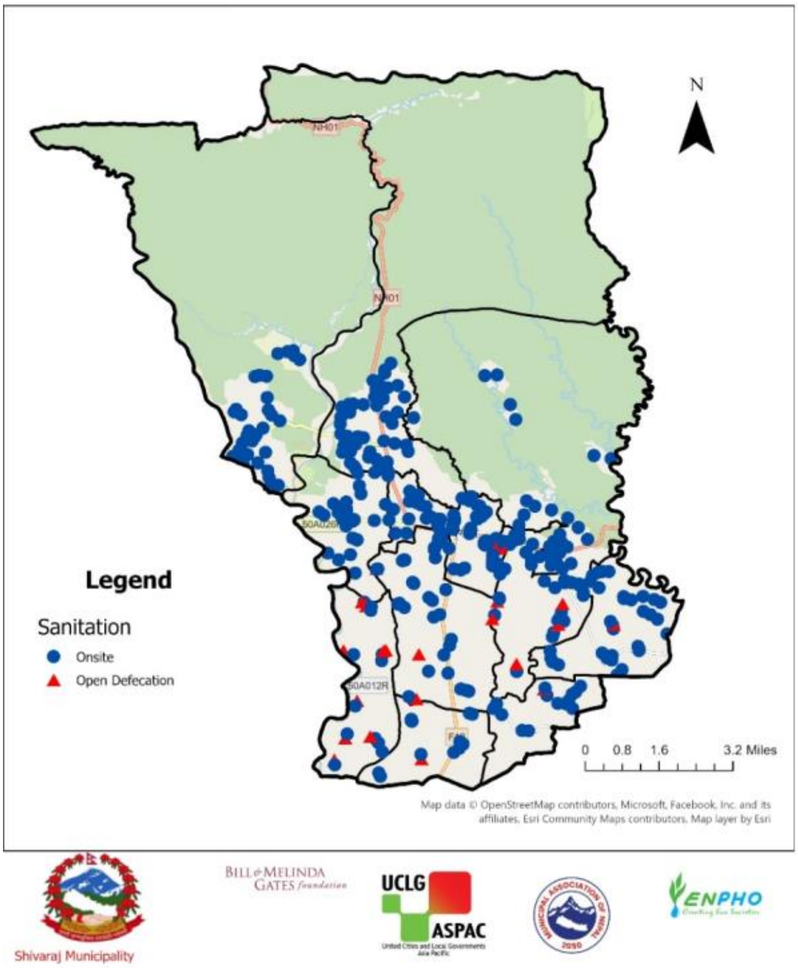

Figure 2: Sanitation systems in the households of municipality.

Any sanitation technology or system involving the collection and storage of excreta (referred to as faecal sludge) on the plot where it is generated is known as onsite sanitation (Susana, 2018). Among the 94% of households that have established containment systems, the distribution of safe onsite sanitation systems is as follows: septic tank in 3% of households, biogas in 9%, fully lined tank in 39%, and twin pits in 12%. A small proportion (3%) of households utilize lined tanks with impermeable walls and open bottoms, and slightly more than a quarter (28%) of households have single offset pits, which, being unsealed, pose a risk of contributing to groundwater and soil contamination.

Table 1 illustrates the various types of onsite sanitation technologies used in the municipality and the corresponding proportion of households utilizing each.

Table 1: Sanitation system showing open defecation, offsite and different onsite sanitation system at households with different types of containments in Shivaraj Municipality. (ENPHO, 2023).

Types of containment	Construction material used in the wall of the containment	Construction material used in the bottom of the containment	Number of Chambers	Containment No.	%	Recategorized as SFD	%
Biogas Digester	NA	NA	NA	NA	9%	Fully lined tank	47%
Fully Lined tank	Cemented brick/stone walls or concrete wall	PCC or plaster	One or two	NA	38%		
Septic tank	Cemented brick/stone walls or concrete wall	PCC or plaster	Two or more than two	NA	3%	Septic tank	3%
Lined tank with impermeable walls and open bottom	Cemented brick/stone walls or concrete wall	Soiling or nothing	One or two or more than two	NA	4%	Lined tank with impermeable walls and open bottom	4%
Single Pit	Concrete rings in piled up form	Soiling or nothing	NA	One	28%	Lined pit with semipermeable walls and bottom	40%
Twin Pits	Concrete rings in piled up form	Soiling or nothing	NA	Two	12%		
Open defecation	NA	NA	NA	NA	6%	Open defecation	6%
						Total	100%

Description on different types of onsite sanitation systems is described as follows.

Septic tank: A septic tank is a well-sealed and waterproof rectangular chamber with an inlet and outlet, featuring two or more chambers for better storage and stabilization of faecal sludge (FS). This properly sealed technology discharges effluent into a soak pit (Susana, 2018) . A well-maintained septic tank efficiently handles black water, reducing environmental pollution and safeguarding public health. In Shivaraj Municipality, only a minimal fraction of the population (3%) has installed a properly designed septic tank in their homes.

Fully lined tank: A fully lined tank is a rectangular tank with impermeable walls and a base, engineered to prevent leakage or seepage of faecal sludge into the surrounding environment. This design ensures the safe storage of faecal sludge, protecting against groundwater contamination (Linda Strande, 2014). In the municipality, 38% of households have fully lined tanks (Figure 3).

Figure 3: Fully lined tank built near the farmland in household level.

Biogas Digester: A biogas digester is an energy conversion technology that can effectively treat faecal sludge generated from households. The anaerobic digestion process decomposes the organic matter in the sludge, reducing its size, eliminating harmful pathogens, and producing biogas and a nutrient-rich slurry. This slurry is biologically stable and can be used as a soil conditioner (Linda Strande, 2014). While making the SFD diagram, biogas is recategorized into SFD containment considering it as a fully lined tank. Currently, less than a one tenth (9%) of households utilize biogas digesters to manage and treat the faecal sludge generated in their homes (Figure 4).

Figure 4: Biogas used in a household of Shivaraj Municipality.

Lined tank with impermeable walls and open bottom: In 4% of households, residents have built a lined tank with impermeable walls and open bottom. This rectangular onsite technology involves constructing tanks with impermeable walls and a permeable base, allowing the infiltration of effluents that could potentially contaminate groundwater (Peal, et al., 2020).

Twin Pit: Ideally, twin pits consist of two properly constructed and well-maintained pits with semi-permeable, honeycombed lined walls and an open, permeable base designed for infiltration, ensuring structural integrity and preventing contamination. These pits effectively treat faecal sludge when there is no exfiltration of water. (Saxena & Den, 2022). The two sets of pits are used alternately to store blackwater, with one pit in use while the other undergoes natural decomposition. These pits are either dug or made by assembling precast concrete rings at a minimum horizontal distance of 1.2m. Both pits are connected through a diversion box. Less than one fifth (12%) of the households have built the twin pit. Figure 5 is of a twin pit built with proper distance maintained between two containments.

Figure 5: Twin pits with proper distance as seen in household.

Single pit: A properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base facilitating infiltration (Susana, 2018). Single pits are typically circular in shape, although design variations may exist based on construction practices. Unlike fully lined tanks, single pits lack a specifically designed outlet for effluent, allowing percolation into the soil. Also, in some households more than one single offset built was also observed as shown in Figure 6. In the municipality, 28% of households have single pits. which could potentially pose environmental and health risks if not managed effectively.

Figure 6: Two different picture of single containment built in different household.

Following map (Figure 7) shows the full picture of different containment location within Shivaraj Municipality.

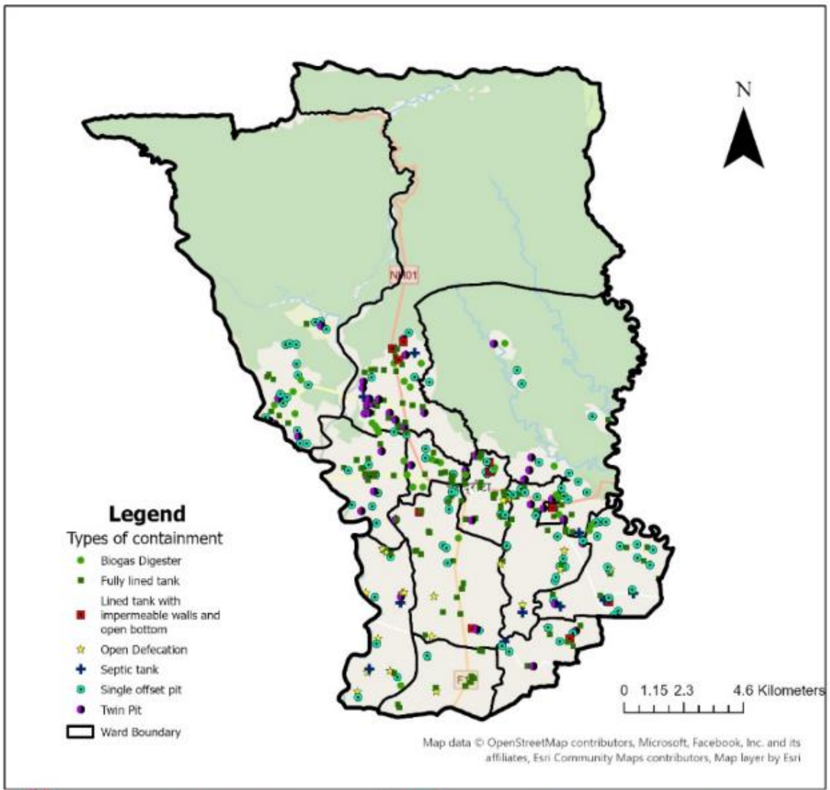

Figure 7: Sanitation technologies installed in household levels.

2.1.2 Emptying and Transportation Services of Containment

Emptying of containment

Emptying is one of the major components of the sanitation service chain. Regular emptying of the containment prevents sludge overflow and blockages (Strande, 2014). It ensures the proper functioning of containment basically for the septic tank which functioned well until the volume of sludge is one-third of the total volume of the tank. Of the total 94% households which had containment, 39% have emptied their containment at least once reason being overflow of faecal sludge. The findings showed that emptying status varied as per the containment.

Regarding the emptied containment intervals, water-sealed containments such as fully lined tanks and septic tanks are typically emptied every 3 to 5 years. In contrast, semipermeable lined pits like single offset pits and twin pits require more frequent emptying. Out of the total emptied containments, 84% were mechanically emptied using private desludging vehicles. The remaining 16% of households emptied their containment through manual processes, utilizing traditional labor or self-emptying, and the sludge is either disposed of in farmlands or dig and dumped.

Figure 8 shows the emptying status of containments in different wards of the municipality. Blue circle in the figure represents the containments that have not been emptied and the red circle represents containments that have been emptied at least once after construction.

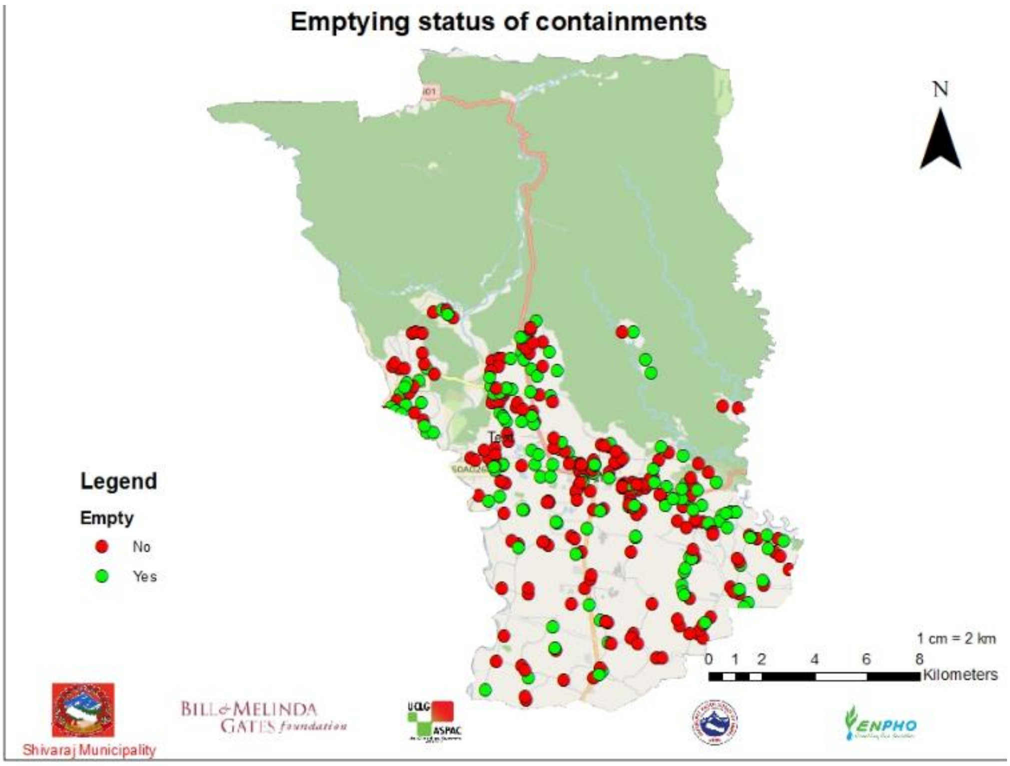

Figure 8: Status of containment emptying in households.

Transportation Services

It is noteworthy that desludging services in the municipality are solely provided by private sectors, with no municipal desludging services available. The municipality has more than four private desludging service providers (KII-1, 2023) two of which were interviewed by the SFD team member. The desludging charges vary depending on the service providers, and there is no fixed or standard price set by private sectors. The majority of desludging vehicles have a capacity of 4,000 litres (Figure 9).

Figure 9: Shivaraj sanitary private desluding vehicle.

The following Table 2 provides details on findings from Key Informant Interviews (KIIs) with private desludging services.

Table 2: Detail Information from private desludgers.

Service Provider	Shivaraj Sanitary	Lumbini Traders
Service Started from	2019 (2076 B.S- services within municipality)	2019 (2076 BS- services within municipality and Buddhabhumi M, Krishnabhumi M)
Capacity of vehicles	4,000 litres	4,000-4,200 litres
Cost Per trip	Minimum $6 (Rs.800), Maximum $14.99 (Rs.2,000) for containment $18.74 (Rs. 2,500) for ring tank (15-16 ring)	Minimum $13.49 (Rs.1,800), Maximum $14.99 (Rs.2,000) for containment Minimum $11.24 (Rs.1,500), Maximum $13.49 (Rs.1,800) for ring tank
Average number of trips per month in peak season	40	35
Number of desludging vehicles	1	1

2.1.3 Treatment and Disposal/Reuse of Faecal Sludge

There is no Faecal Sludge Treatment Plant (FSTP) available in the municipality or in nearby municipalities. Survey findings reveal that 74% of the surveyed households indicated that collected faecal sludge is disposed of in farmland, either through manual or mechanical collection in an unsafely way. An additional 8% mentioned faecal sludge is generally discarded in forest areas, while 17% had no knowledge of its disposal, and 1% believed it is thrown into water bodies.

Further insights from private desludgers and municipal staff indicate varied disposal practices among private desludgers. Common practices include disposing of faecal sludge in the farmlands of service takers upon their request. Additionally, some desludgers have allocated separate confined land areas for faecal sludge dumping (KII-5, 2023), while others dispose of it in open lands far from residential areas (KII-4, 2023). Unfortunately, some private desludgers were found to be illegally dumping faecal sludge into water bodies. Meanwhile, those practising manual emptying were found to utilize the faecal sludge as manure in farmlands with no proper pre-treatment.

2.1.4 Sanitation System in institutions of Shivaraj Municipality

All the surveyed institutions had access to a safely managed sanitation system in the municipality. 51% institutional buildings had made lined tanks with impermeable walls and open bottom, 36% had built fully lined tanks, 9% septic tanks and 5% had lined pits with semipermeable walls and open bottom (Figure 10).

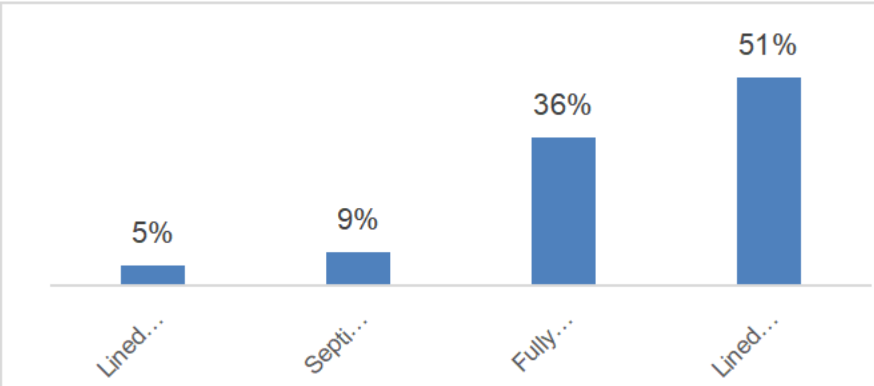

Figure 10: Types of containment in institutions of Shivaraj Municipality.

Approximately 33% of institutions have emptied their containment at least once since construction, while the remaining institutions have never undergone containment emptying. Notably, all instances of containment emptying in these institutions are carried out through mechanical desludging.

2.1.5 Public Toilets

Public Toilets (PT) are installed for commuters to achieve and sustain open defecation-free status in the municipality. Two public toilets are installed, one in Balapur Chowk and one in Chandrauta Bazaar to serve the moving population and travellers of the municipality. Specifically, these public toilets are built focusing the market area where there is more crowd on Haat Bazaar time. One of the public toilets shown is currently under construction and is not functional, while one is open only during some special event as Haat Bazaar, festival time (Figure 11).

Figure 11: Public toilets in Shivaraj Municipality.

2.1.6 Risk Assessment of Groundwater Pollution from open bottom containment

The risk of groundwater pollution was assessed based on source of drinking water, secondary data on water quality and the depth and vulnerability of the aquifer with regards to lateral spacing between sanitation system and groundwater sources.

a. Sources of Drinking Water

The findings indicate that the majority of households (82.93%) in the municipality depend on groundwater sources for their drinking water. Additionally, 13.6% have private or yard taps installed in their own household premises, while 0.27% use public or community taps as their primary source of drinking water. A small percentage (3.20%) of households in the central area of the municipality, Chandrauta, rely on jar water for drinking purposes. The KII findings from water sanitation and user committee revealed that Chandrauta water sanitation and users committee has been providing drinking water service in ward 5 whose catchment area are Dahagaon, Sauni, Bargadau and Balkamore (KII-3, 2023). Likewise, one in ward 9 named Shivgadi sanitation and users committee has been providing drinking water service in 4 village: Anchalpur, Bijgauri, Baniyabari and Rauniyadaha (KII-2, 2023). It was found that the major source was boring water from depth 400-500 feet (121.9 - 152.4 m) and very few users committee do water treatment using chlorine before dispatching it to users.

KII with Water Sanitation and User Committees (WSUC) revealed that the Chandrauta WSUC serves in Ward 5, covering the catchment areas of Dahagaon, Sauni, Bargadau, and Balkamore and providing services to more than 1,500 households. Similarly, in Ward 9, the Shivgadi WSUC provides services in four villages: Anchalpur, Bijgauri, Baniyabari, and

Rauniyadaha distributing services to 650 households. It was observed that the major water source for these committees is boring water from depths of 400-500 feet (121.9 - 152.4 m), and very few user committees practice water treatment using chlorine before distributing it to users.

b. The vulnerability of the aquifer and lateral spacing between sanitation systems and groundwater source

The term aquifer pollution vulnerability is intended to represent the varying level of natural protection afforded by the contaminant attenuation capacity of the unsaturated zone or semi-confining beds above an aquifer, because of physicochemical processes (filtration, biodegradation, hydrolysis, adsorption, neutralization, volatilization, and dispersion)—all of which vary with their texture, structure, clay content, organic matter, pH, redox and carbonate equilibria. Groundwater vulnerability is specific to containment type and pollution scenarios (Andreo, 2013).

A key determinant of risk variation is the soil and geological setting. Especially for consolidated hard rock sediments with poor soil cover and shallow water tables, the risk is higher. According to WHO criteria, if the travel time of pollutant to groundwater source is less than 25 days, there is significant risk to contamination; low risk, if the travel time is between 25 and 50 days; and very low risk if the travel time is greater than 50 days (Krishnan, 2011). The size of pores in the soil determines the infiltration rate. In the sandy loam soil, the permeability is approximately 2.5 cm per hour. Thus, between 25 and 50 days the pollutant could travel to the depth of approximately 30 metres (98.67 feet) in sandy loam soil. People using open bottom tanks and consuming water from the handpumps with the depth up to 100 feet (30.4 m) and horizontal distance of the pump within 25 feet (7.6 m) from the source of pollutants are assumed at significant risk to groundwater pollution.

The risk of groundwater pollution in Shivaraj Municipality was assessed by considering various factors, including the source of drinking water, aquifer vulnerability concerning lateral spacing between sanitation systems and groundwater sources, and secondary data from water quality tests. According to MICS data in Lumbini province, there was 82.6% faecal contamination in source water (MICS, 2019). Additionally, water quality tests conducted by Shivaraj Municipality in 2019 (2076 BS) on handpump sources below the depth of 100 feet (30.4 m) revealed the presence of *E.coli* in groundwater. Among different types of containment systems, lined tanks with impermeable walls and open bottoms, and lined pits with semi-permeable walls and open bottoms are identified as more likely to contribute to aquifer pollution. This is due to the potential seepage from these types of containments that can readily infiltrate the surrounding soil and groundwater, causing contamination. Therefore, individuals using open-bottom tanks and consuming water from handpumps with depths up to 100 feet (30.4 m) and horizontal distances of the pump within 25 feet (7.6 m) from the source of pollutants are assumed to be at significant risk of groundwater pollution.

Figure 12 illustrates the depth of hand pumps and their horizontal distance from lined pits with semi-permeable walls and an open bottom (twin pits and single offset pits). In total, 40% of households have installed lined pits with semi-permeable walls and an open bottom. Among these, 84% of households use groundwater as a source of drinking water, and it was found that 41% of these households are at high risk of groundwater contamination due to the water being pumped through hand pumps. Thus, the population with lined pits having semi-permeable walls and an open bottom, without outlet or overflow, and presenting a significant risk of groundwater pollution (T2A5C10) is 14% (calculated as 40% x 84% x 41% = 14%).

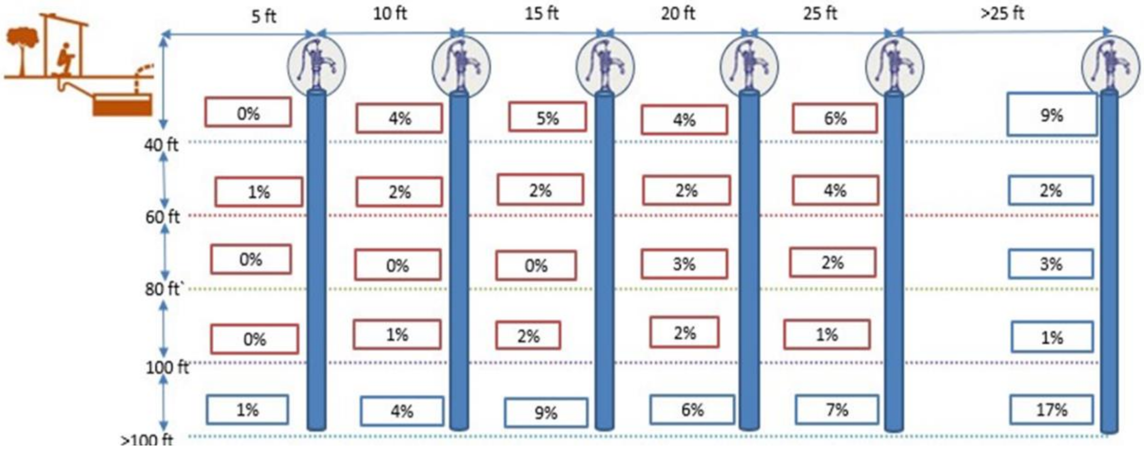

Figure 12: Depth of hand pumps and lateral spacing of it with containment types lined pit with semi-permeable walls and open bottom.

Figure 13 illustrates the depth of hand pumps and their horizontal distance from lined tanks with impermeable walls and an open bottom. Specifically, 4% of households have installed lined tanks with impermeable walls and an open bottom, of which 92% rely on groundwater for drinking. Among these households, it was revealed that 66% are at a high risk of groundwater contamination due to the water pumped through hand pumps. Consequently, the population with lined tanks having impermeable walls and an open bottom without outlet or overflow and presenting a significant risk to groundwater pollution (T2A4C10) is 2% (calculated as 3% x 92% x 66% = 2%).

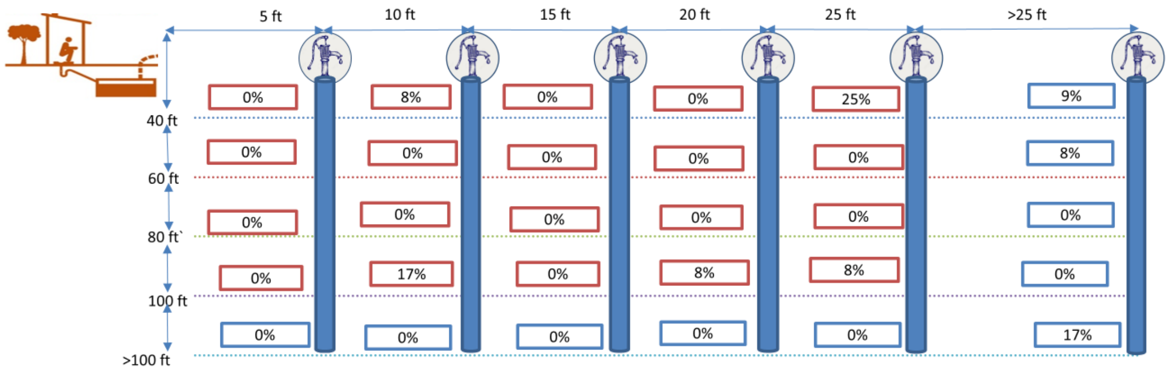

Figure 13: Depth of hand pumps and lateral spacing of it with containment types lined tank with impermeable walls and open bottom.

2.2 SFD Selection Grid

The SFD grid consist of different containment technology used in list A and its connection in list B. Sanitation technologies selected in the SFD grid in Shivaraj Municipality are shown in Figure 14. The vertical column in the left side of the SFD selection grid has a list of technologies to which the toilet is connected to, and households without toilet resorting to open defecation. Similarly, horizontal row at the top of the selection grid shows options for connection made for the outlet or overflow of discharge from the toilet.

As per the definition of containment made by Shit Flow Diagram Promotive Initiative (SFD PI), different containments are recategorized into different SFD containment. For example, biogas is reclassified as a fully lined tank, given that the walls and bottom of the biogas structure are water-sealed and share similar features with a fully lined tank. Similarly, single pits and twin pits, constructed by assembling pre-cast concrete rings on top of each other, are collectively referred to as lined pits with semipermeable walls and an open bottom. However, fully lined tanks and septic tanks do not require reclassification and remain unchanged. After the reclassification of these containments, the types of sanitation technologies and their connections are chosen in the SFD selection grid, as illustrated in Figure 14.

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					Significant risk of GW pollution Low risk of GW pollution	T1A2C6		T1A2C8		
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution	T1A3C6		T1A3C8		T1A3C10
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	T1A4C6		T1A4C8		T2A4C10 T1A4C10
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable							T1B11 C7 TO C9		Not Applicable

Figure 14: SFD selection grid for Shivaraj Municipality.

´A brief explanation of terms used to indicate different frames selected in the SFD selection grid is explained in Table 3.

Table 3: Explanation of terms used to indicate different frame selected in the SFD selection grid.

T1A2C6	This is a correctly designed, properly constructed, fully functioning septic tank with an outlet connected to an open drain or storm sewer. The supernatant/effluent flowing from the tank is only partially treated and is still hazardous, therefore all the excreta in this system is considered not contained.
T1A2C8	This is a correctly designed, properly constructed, fully functioning septic tank with an outlet connected to an open ground. The supernatant/effluent flowing from the tank is only partially treated and is still hazardous, therefore all the excreta in this system is considered not contained.
T1A3C6	A correctly designed, properly constructed, and well maintained fully lined tank with impermeable walls and base. Since the tank is fitted with a supernatant/effluent overflow connected to an open drain or storm sewer the excreta in this system are considered not contained.
T1A3C8	A correctly designed, properly constructed and well-maintained fully lined tank with impermeable walls and open bottom. Since the tank is fitted with a supernatant/effluent overflow connected to open ground the excreta in this system are considered not contained.
T1A3C10	A correctly designed, properly constructed and well-maintained fully lined tank with impermeable walls and base. Since the tank is not fitted with a supernatant/effluent overflow this system is considered contained.
T1A4C6	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. Since the tank is fitted with a supernatant/effluent overflow connected to an open drain or storm sewer, the excreta in this system are considered not contained.
T1A4C8	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. Since the tank is fitted with a supernatant/effluent overflow connected to open ground, the excreta in this system is considered not contained.
T2A4C10 (High Risk)	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur - the excreta is therefore likely to be partially treated. The tank is not fitted with a supernatant/effluent overflow but since there is a 'significant risk' of groundwater pollution this system is considered not contained.
T1A4C10	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. However, since the tank is not fitted with a supernatant/effluent overflow this system is considered contained.
T2A5C10 (High Risk)	A correctly designed, properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow but since there is a 'significant risk' of groundwater pollution this system is considered not contained.
T1A5C10	A correctly designed, properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow, so this system is considered contained.
T1 B11 C7 to C9	With no toilet, users defecate in water bodies, on open ground and to don't know where; consequently, the excreta is not contained.

2.3 SFD proportion and matrix

2.3.1 Proportion of Faecal Sludge from types of sanitation technologies

In the second step of developing an SFD graphic, the proportion of Faecal Sludge (FS) in each type of sanitation technology is calculated. Following detailed instructions in SFD PI, a default "100%" value is applied when onsite containers are connected to soak pits, water bodies, or open ground, representing the entire contents as faecal sludge, with a portion being periodically emptied.

For onsite containers connected to a sewer network or open drains, a "50%" value is used, indicating that half the contents are modelled as faecal sludge, with periodic emptying. The remaining fraction contains faecal sludge in the container and infiltrate (for open-bottomed tanks), while the other half is modelled as supernatant discharging into the sewer network or open drains. The formula for calculating FS proportion is provided below:

$$\frac{(Onsite\ container\ connected\ to\ soak\ pit, no\ outlet, water\ bodies\ or\ open\ ground) * 100 + (Onsite\ container\ connected\ to\ sewer\ network\ or\ open\ drain) * 50}{Onsite\ Container}$$

The calculated FS proportion in each type of sanitation technologies are:

1. The proportion of FS in septic tanks is 83%. When septic tanks are connected to stormwater drains or open drains, the FS proportion is considered to be 50% of the total accumulated in the containment. This implies that nearly 50% of FS from such containments is discharged into open or stormwater in the form of supernatant.
2. The proportion of FS in fully lined tanks is calculated as 99%. If fully lined tanks are connected to an open drain, the FS proportion is considered to be 50% of the total FS.
3. The FS proportion from lined tanks with open bottoms and all types of pits is 98%, as connection is made to an open drain, the FS proportion is considered to be 50% of the total FS.

After determining the proportion of FS in each type of sanitation technology, the corresponding population proportions from the selected technologies in the SFD selection grids are set. Figure 15 illustrates the SFD matrix of the municipality.

Shivaraj Municipality, Lumbini, Nepal, 1 Jan 2024. SFD Level: 2 - Intermediate SFD
Population: 84810
Proportion of tanks: septic tanks: 83%, fully lined tanks: 99%, lined, open bottom tanks: 98%

Containment						
System type	Population	FS emptying	FS transport	FS treatment	SN transport	SN treatment
	Pop	**F3**	**F4**	**F5**	**S4e**	**S5e**
System label and description	Proportion of population using this type of system (p)	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants, which is treated
T1A2C6 Septic tank connected to open drain or storm sewer	1.0	23.0	0.0	0.0	0.0	0.0
T1A2C8 Septic tank connected to open ground	2.0	13.0	0.0	0.0		
T1A3C10 Fully lined tank (sealed), no outlet or overflow	40.0	37.0	49.0	95.0		
T1A3C6 Fully lined tank (sealed) connected to an open drain or storm sewer	1.0	0.0	0.0	0.0	0.0	0.0
T1A3C8 Fully lined tank (sealed) connected to open ground	6.0	12.0	0.0	0.0		
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	1.0	54.0	0.0	0.0		
T1A4C6 Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer	0.5	0.0	0.0	0.0	0.0	0.0
T1A4C8 Lined tank with impermeable walls and open bottom, connected to open ground	0.5	0.0	0.0	0.0		
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	26.0	37.0	0.0	0.0		
T1B11 C7 TO C9 Open defecation	6.0					
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	2.0	0.0	0.0	0.0		
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	14.0	46.0	0.0	0.0		

Figure 15: SFD Matrix of Shivaraj Municipality.

2.3.2 Proportion of Faecal Sludge Emptied (F3)

Here, data for each selected sanitation system on the SFD Matrix is entered. The proportion of the contents of each type of onsite container (septic tanks, fully lined tanks (sealed), lined tanks with impermeable walls and open bottom and lined pit with impermeable walls and open bottom), is shown in column Population (Pop) of Figure 15.

Variable F3 represents the proportion of the contents of each type of onsite container which is emptied at least once after its construction. Here, as per the findings of KII and data from household survey (ENPHO, 2023), only 90% of the proportion of FS in the containment is emptied (KII-4, 2023; KII-5, 2023). An average of 10% of the FS in the containment, characterized by high thickness and poor water solubility, remains unremoved during emptying, as reported from KII with desludger information. The calculation of the emptied proportion of FS is adjusted accordingly as follows (Table 4).

$$Actual\ Proportion\ of\ FS\ emptied\ (F3) = percentage\ of\ containment\ emptied\ \times\ proportion\ of\ FS\ removed\ during\ emptying$$

Table 4: Sanitation technologies and proportion of emptied faecal sludge (ENPHO, 2023[1]; KII-4 and KII-5, 2023[2]).

Sanitation Technologies	SFD Reference Variable	Percentage of Emptied Containment (1)	Emptied Proportion of FS (2)	Actual Proportion of Emptied FS (F3)
Septic tank connected to open drain	T1A2C6	25%	90%	23%
Septic tank connected to open ground	T1A2C8	14%	90%	13%
Fully lined tank (sealed) connected to an open drain or storm sewer	T1A3C6	0%	0%	0%
Fully lined tank (sealed), no outlet or overflow	T1A3C10	41%	90%	37%
Fully lined tank connected to open ground	T1A3C8	14%	90%	12%
Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer	T1A4C6	0%	0%	0%
Lined tank with impermeable walls and open bottom, connected to open ground	T1A4C8	0%	0%	0%
Lined tank with impermeable walls and open bottom, no outlet or overflow	T1A4C10	60%	90%	54%
Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	T2A4C10	0%	0%	0%
Lined pit with semi-permeable walls and open bottom, no outlet or overflow	T1A5C10	41%	90%	37%
Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	T2A5C10	51%	90%	46%

2.3.3 Proportion of FS emptied which is delivered to Treatment Plant (F4 and F5)

Variable F4 accounts for FS emptied that is transported to treatment plant. Since there is no treatment plant available in the municipality, the collected sludge through mechanical desludging is not treated. Only the operational biogas systems are classified as treated (F5). In the provided matrix, 48% of fully lined tanks, including 9% with functioning household biogas digesters, are considered treated with 95% efficiency (F5=95%).

As explained earlier, fully lined tank (sealed) no outlet or overflow (40%), is comprised of two types of containments; biogas digesters and fully lined tank without outlet. 37% of T1A3C10 emptied that is shown in F3, is the sum of biogas digester and fully lined tank without outlet which has been emptied. 49% of T1A3C10 emptied pertains to biogas digester, which is considered as FS transported to treatment plant. 95% of T1A3C10 delivered to treatment plant is treated as seen in column F5.

For the rest of the sanitation systems, all other values of F4 and F5 are zero because there is no treatment plant established in the area. FS emptied is either disposed on top of farmlands or on open ground far from residential area which cannot be considered as treated.

2.4 Summary of Assumptions

Offsite sanitation Systems:

- ✓ There is no sewer network in the municipality. 3% of the households depends on sanitation systems discharging their effluents in open drains (T1A2C6, T1A3C6 and T1A4C6). As there is no FSTP, variables S4e and S5e are both set to 0% in these systems.

Onsite Sanitation Systems:

- ✓ The proportion of FS in septic tanks was set to 83%, the proportion of FS in fully lined tanks was set to 99% and the proportion of FS in lined tanks with impermeable walls and open bottom and all types of pits was set to 98% according to the relative proportions of the systems, as per the guidance provided by SuSanA.
- ✓ Variables F3, F4 and F5 for all onsite sanitation systems were derived from the household survey and cross-checked with KIIs conducted.
- ✓ FS from anaerobic biogas digesters, classified as fully lined tanks (system T1A3C10), is considered as transported (F4=49%) and treated with a treatment efficiency estimated at 95% (F5=95%).
- ✓ Since there is no FSTP, all values for variables F4 and F5 were set to 0% for the rest of the systems.

2.5 SFD Graphic

Figure 16 presents diagrammatic representations of the excreta flow within the municipality.

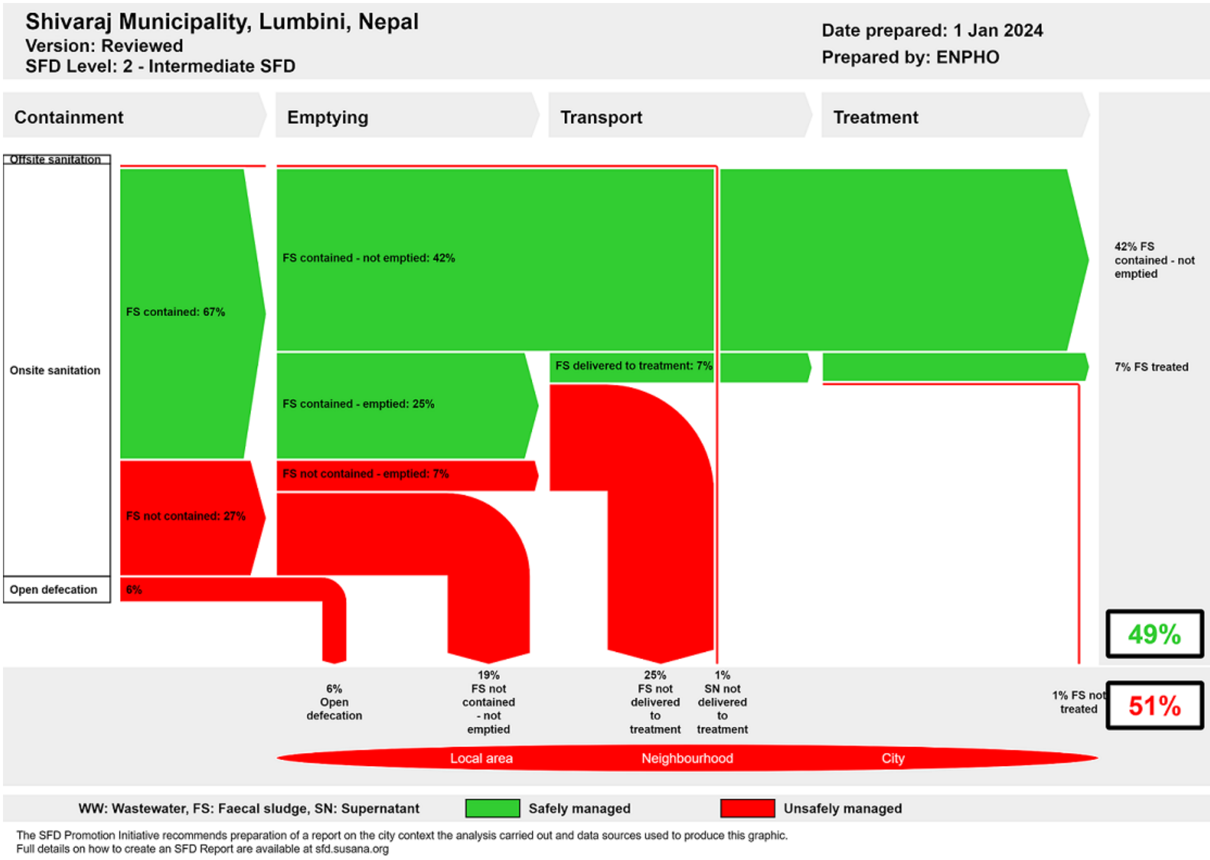

Figure 16: SFD graphic of Shivaraj Municipality.

The color scheme signifies the nature of sanitation systems, with green indicating safely managed systems and red denoting unsafely managed ones. The diagram reveals that faecal sludge (FS) generated from 49% of the population is safely managed, represented by "Green" arrowheads, indicating FS stored in containment without significant risk to groundwater.

Conversely, FS from 51% of the population is unmanaged, represented by "Red" arrowheads. This signifies not contained FS and openly dumped FS emptied from the containments, both considered unsafe. The diagram illustrates four different factors across the sanitation value chain, arranged from left to right.

2.4.1 Onsite Sanitation

The 94% percent of the population in Shivaraj Municipality utilizes onsite sanitation technologies for managing excreta. Among them, FS from 67% of the population is appropriately stored in technically effective containment, as depicted by "FS contained" in the SFD graphic. On the other hand, FS from the remaining 27% of the population is stored in unsafe containment, represented as "FS not contained."

FS contained

The term 'FS contained' refers to faecal sludge within an onsite sanitation technology that ensures a safe level of protection from excreta, limiting pathogen transmission to the user or the general public. These containment systems, such as tanks or pits, are correctly designed, properly constructed, fully functioning, and pose little to no risk of polluting groundwater used for drinking (Susana, 2018). In the municipality, FS generated by 67% of the population is contained. The value of FS contained (67%) is derived from the summation of the percentage of the population using the following containment systems: fully lined tank without outlet or overflow (T1A3C10), lined tank with impermeable walls and open bottom without outlet or overflow (T1A4C10), and lined pit with semi-permeable walls and open bottom without outlet or overflow (T1A5C10). This is multiplied by the proportion of FS contained in each specific containment.

FS not Contained

The term 'FS not contained' refers to faecal sludge within an onsite sanitation technology that does not ensure a safe level of protection from excreta, with a likely risk of pathogen transmission to the user or the general public. These containment systems, such as tanks or pits, are incorrectly designed, poorly constructed, poorly functioning, and/or pose a 'significant' risk of polluting groundwater used for drinking (Susana, 2018). In the municipality, FS generated by 27% of the population is not contained. The value of FS not contained (27%) is obtained from the summation of the percentage of the population using the following containment systems: septic tank connected to open drain or storm sewer (T1A2C6), septic tank connected to open ground (T1A2C8), Fully lined tank (sealed) connected to an open drain or storm sewer (T1A3C6), Fully lined tank (sealed) connected to an ground (T1A3C8), Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer (T1A4C6), lined tank with impermeable walls and open bottom, connected to an open ground (T1A4C8), Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A4C10), Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A5C10), open defecation (T1B11 C7 TO C9).

FS contained - not Emptied

It is faecal sludge that is contained within an onsite sanitation technology but not removed may persist within the container or infiltrate into the ground, depending on the type of sanitation technology in use (Susana, 2018) The value of 42% is obtained from the proportion of the population using sanitation systems where the FS is contained and have not emptied their containment. However, this 42% of safely managed FS should be considered as only temporary, as most of the pits and tanks have not yet filled up and the status might change. These systems will require emptying services in the short and medium term as they fill up and which will change their status depending on how they are transported and treated after their emptying.

FS contained - Emptied

It is faecal sludge which is removed from an onsite sanitation technology where it is contained and can be emptied, utilizing either mechanical or manual emptying equipment. The value of 25% is obtained from the proportion of population using sanitation systems where the FS is contained and have emptied their containment.

FS not contained - Emptied

In this faecal sludge is removed from an onsite sanitation technology where it is not contained and can be emptied, utilizing either mechanical or manual emptying equipment. The value of 7% is obtained from the proportion of the population using sanitation systems where the FS is not contained and have emptied their containment.

FS not contained - not Emptied

It is faecal sludge that is not contained within an onsite sanitation technology and not removed may persist within the container or infiltrate into the ground, depending on the type of sanitation technology in use. The value of 19% is obtained from the proportion of the population using sanitation systems where the FS is not contained and not emptied.

FS not delivered to treatment

The proportion of FS not delivered to treatment, i.e. 25%, is the summation of FS contained emptied and FS not contained emptied. Since the municipality does not have a FSTP or any other treatment option, faecal sludge are dumped into the farmland, water bodies and not considered treatment. Thus, the collected faecal sludge from mechanically emptying is also dumped into farmland or open areas where there is no residential area around. Additionally, there is still practice of manual emptying and those who manually emptied their containment, such FS are also not delivered to treatment plant. The emptied FS is disposed of untreated to farmlands. Thus, this proportion of FS possesses risk to local area and neighbourhood.

FS delivered to treatment

The proportion of FS delivered to treatment is 7% which is specially the FS that comes from the biogas. This proportion mainly comes from the biogas digester as the functioning biogas are considered treatment.

SN not delivered to treatment

These 1% of the supernatant are from containment facilities connected to open drain or storm sewers which are also not treated.

2.4.2 Open Defecation

It is a situation where no toilet is in use, and people resort to open defecation in fields, forests, bushes, bodies of water, or other open spaces. Despite municipality having Open Defecation Free (ODF) status, 6% of population still defecate openly. Mostly, the households living in poverty and those who do not own land do not have toilets.

3. Service delivery context description

3.1 Policy, legislation, and regulation

The constitution of Nepal 2015 has established right to access to clean drinking water and citizen as fundamental right. In Article 35 (4) related to right to health recognizes citizen's rights to access to clean drinking water and sanitation. In addition, Right to Clean Environment, Article 30 (1) recognizes that every person shall have the right to live in a healthy and clean environment (GoN 2015). To respect and promote the right of citizens to wards accessing clean drinking water and sanitation services, the government has promulgated and amended necessary laws. The most relevant legislation for promotion of safe sanitation services is discussed here.

Local Government Operation Act, 2017

Local Governance Operation Act 2017 has promulgated to implement the rights of local government and promote co-operation, co-existence, and co-ordination among federal, provincial, and local government. The act defined roles and responsibility of municipalities along with provision and procedure for approving laws and regulations at local level. Regarding the management of sanitation, the act entitles local government to conduct awareness campaigns, design and implement sanitation programs at the local level.

Environment Protection Act, 2019

Environment protection act 2019 is promulgated to prevent and control pollution from different development activities. It defines "Pollution" as the activities that significantly degrade, damage the environment, or harm the beneficial or useful purpose of the environment, by changing the environment directly or indirectly because of wastes, chemical, heat, noise, electrical, electro-magnetic wave, or radioactive ray. It provides the mechanism for appointing environmental inspector to control pollution by federal, provincial, and local government.

Water Supply and Sanitation Act, 2022

The act was promulgated to ensure the fundamental right of citizen to easy access on clean and quality drinking water, sanitation services and management of sewerage and wastewater. It defines sewerage and wastewater management as construction of sewer networks and treatment plants to preserve sources of water. It has entitled federal, provincial, and local level for the operation and management of water and sanitation services. The act also explicitly defines the responsibility of every citizen to preserve, conserve and maintain the sources of water and use responsibly.

Environment Friendly Local Governance Framework 2013

The environment-friendly local governance framework 2013 has been issued to add value to environment-friendly local development concept encouraging environmental protection through local bodies. The framework has set basic and advanced indicators for households, settlement, ward, village, municipality, and district levels for declaration of environment friendly. The use of water sealed toilets in households as basic indicators for sanitation and health. Provision of toilet with safety tank and use as advanced indicators for sanitation. Provision of gender, children and disabled friendly public toilets in parks, petrol pumps and main market as basic indicator for municipal level. Advance indicators such as drainage discharged only after being processed through biological or engineering technique. While it has failed to identify the necessity of faecal sludge treatment plants as it has assumed safety tank in the households is sufficient for treating faecal sludge.

Institutional and Regulatory Framework for Faecal Sludge Management, 2017

Ministry of Water Supply through its Department of Water Supply and Sewerage Management (DWSSM) articulated and endorsed Institutional and Regulatory Framework (IRF) for Faecal Sludge Management in Urban Areas of Nepal in 2017. The main objective of the IRF is to define the specific roles and responsibilities of key institutions for the effective management and regulation of FSM. The framework primarily envisioned featuring FSM in the national policy and issuing policy directives into local government to incorporate FSM in their urban planning along with strengthening and enhancing the capacity of the local government to deliver effective services. A local government has been endowed with overall responsibility to plan, implement, and regulate the FSM services within its jurisdiction. The provision of the ability to engage the private sector and other relevant stakeholders such as the Water and Sanitation Users Committee (WSUC) in the framework reflects a participatory approach that would help in sustaining the interventions.

Total Sanitation Guideline, 2017

Total Sanitation Guideline was promulgated by the Ministry of Water Supply in April 2017 after the successful implementation of National Sanitation and Hygiene master Plan (NSHMP) 2011. It provides guidelines for sustaining ODF outcomes and initiating post-ODF activities through an integrated water, sanitation and hygiene plan at municipalities and districts. The guideline redefined sanitation as management of services and facilities to safely dispose of/reuse faecal sludge, collection and treatment of solid waste and wastewater to establish a hygienic environment and promote public health. Indicators are set to guide total sanitation movement with an arrangement for resource management, monitoring and evaluation, capacity building.

3.1.1 Policy

Historically, the National Sanitation Policy (1994) was the guideline for the planning and implementation of sanitation programs. The policy had promoted sanitation issues together with issues on water supply in rural communities. Also, Rural Water Supply and Sanitation National Policy (RWSSNP) 2004, has set a new target to provide safe, reliable, and affordable water supply with basic sanitation facilities. The policy focused on delivering quality services on water and sanitation to the marginalized and vulnerable groups. However, it was unable to address the complex operational issue of urban water supply and sanitation service delivery. Thus, the National Urban Water Supply and Sanitation Sector Policy (NUWSSSP) was formulated and enforced in 2009. It focused on achieving coherent, consistent, and uniform approaches of development in urban areas with the involvement of different agencies and institutions. Both these policies were limited to addressing emerging issues and challenges in the rural and urban areas. Thus, the National Water Supply and Sanitation Policy (NWSSP) was formulated in 2014 by GON to address the emerging challenges and issues with the adoption of new approaches and resolve the inconsistency in RWSSNP and NUWSSSP.

The goal of the NWSSP was to reduce urban and rural poverty by ensuring equitable socio - economic development, improving health and the quality of life of the people and protection of environment through the provision of sustainable water supply and sanitation services. It adopted innovative technologies and knowledge emerged in the sector. Remarkably, it was the first official document that recognized discharge of untreated wastewater and dumping of septic sludge heavily polluted the surface water sources in urban areas.

Nepal is a signatory of the historical resolution of 2010 United Nations General Assembly on the Human Right to Water and Sanitation. Nepal committed to Millennium Development Goals (MDGs) for 2000- 2015 The goal was accomplished through declaration of the country as free from open defecation on 30th September 2019. National Sanitation and Hygiene Master Plan, 2011 was developed for coordinated planning and implementation of National Sanitation Campaign. The campaign strengthened institutional setup tier of government in a participatory approach. In an alignment total sanitation campaign was initiated formally to sustain ODF. The guideline set various indicators to assess the sustainability of sanitation services. Remarkably, it extended sanitation definition as management of services and facilities to safely dispose of/reuse faecal sludge, collection and treatment of solid waste and wastewater to establish the hygienic environment and promote public health (NPC, 2017).

Similarly, Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (SDP 2016-2030) was formulated in 2016 for sector convergence, institutional and legal reforms, capacity development and establishing coordination and harmonization in the sector. The SDP classified service system and delineated roles and responsibilities for effective and sustainable service delivery. The SDP highlighted that majority of households rely on onsite sanitation system (70%) that requires effective treatment of faecal sludge. However, there is lack of concrete policies, guidelines, and indicators on Faecal Sludge Management in the sector for effective planning, implementation, and service delivery.

Shivraj Municipality does not have any separate specific WASH unit for sanitation. However, sanitation sub-section is under the Infrastructure Development and Environment Management Section. Also, there is no any specific policies made for water, sanitation or faecal sludge management.

3.1.2 Institutional roles

Federal, provincial, and local government are entitled for implementation of water and sanitation programs to ensure the rights on access to safe water and sanitation.

At Federal Government

National Planning Commission: At the federal government, the National Planning Commission is the specialized and apex advisory body for formulating a national vision, developing policy, periodic plans, and sectoral policies. The NPC assesses resource needs, identifies sources of funding, and allocates budget. It serves as a central agency for monitoring and evaluating development policy, plans and programs. It supports, facilitates, and coordinates with federal, provincial, and local government for developing policy plans and implementation.

Ministry of Water Supply: Ministry of Water Supply is the lead ministry responsible for planning, implementation, regulation, and monitoring and evaluation of sanitation programs in the country (GoN, 2015). Under the MoWS, Department of Water Supply and Sewerage Management (DWSSM) is the lead agency to plan and implement water and sanitation projects funded by foreign donors or inter provincial projects or serves at least 15,000, 5,000 and 1,000 people in terai, hilly and mountain region respectively (GoN, 2015). The organizational structure of DWSSM is shown in Figure 17.

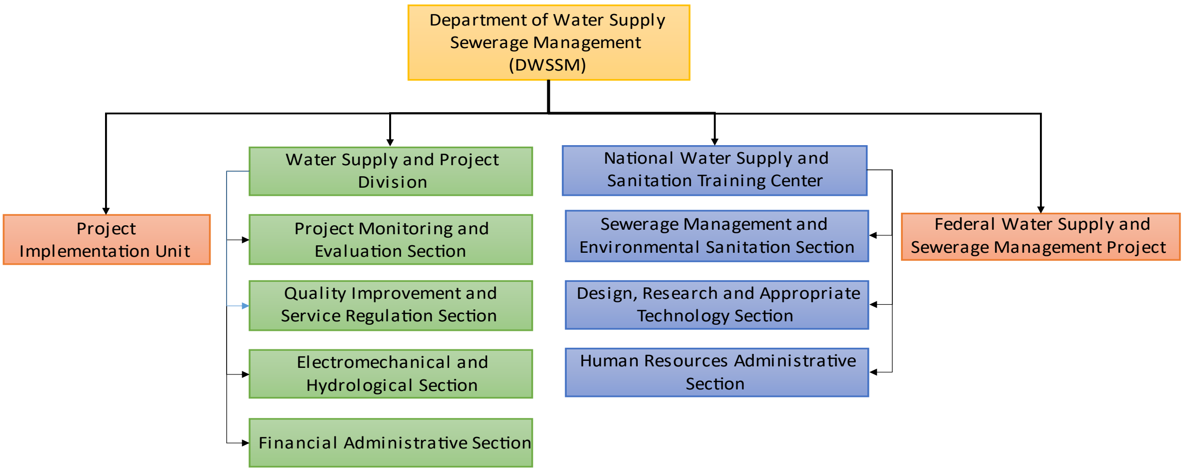

Figure 17: Organizational Structure Department of Water Supply and Sewerage Management (DWSSM).

At Provincial Government

Ministry of Physical Infrastructure: Ministry of water supply and Urban development of provincial government in Lumbini province is major executing body for planning, developing, and implementing water supply and sanitation programs. Planning and implementation of water supply and sanitation infrastructure in the province is executed through Water supply and Sanitation Divisional Office (WSSDO). WSSDO implements the water and sanitation programs meeting the following criteria:

i. Inter local government projects.

ii. Beneficiaries between 5,000 to 15,000 in terai region, 3,000 to 5,000 in hilly region and 500 to 1,000 in Himalayan region.

At Local Government

Municipal council: Figure 18 shows the organogram of the municipality. The sanitation sub-section is under the Infrastructure Development and Environment Management Section.

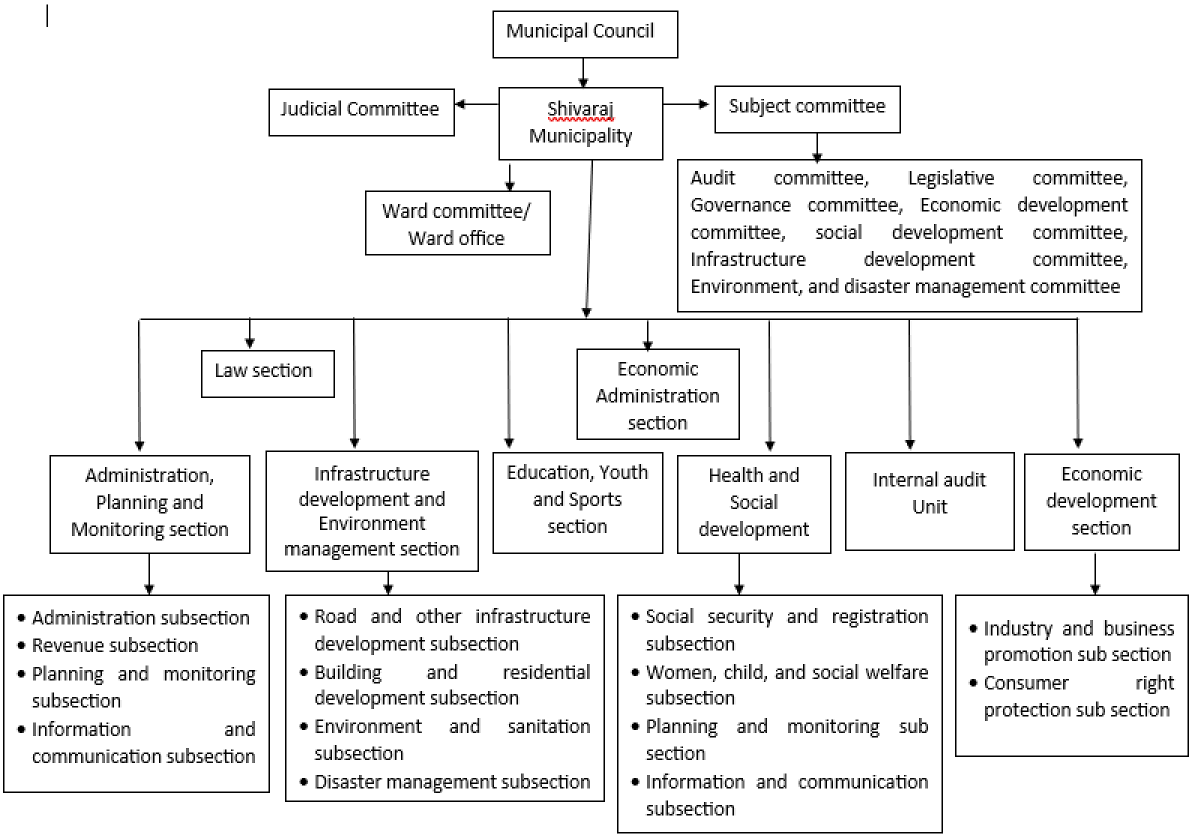

Figure 18: Organogram of Shivaraj Municipality.

3.1.3 Service provision

Urban Water Supply and Sanitation Policy 2009 has emphasized the Public-Private Partnership (PPP) in water supply and sanitation to improve service delivery (MoPIT, 2009). Also, the Public-Private Partnership Policy, 2015 encourages private sector investment in the development and operation of public infrastructure services for comprehensive socioeconomic development. The policy has aimed to remedy challenges such as structuring of projects, land acquisition, coordination and approval, payments to private sectors and approval for environment impact (MoF, 2015).

3.1.4 Service standards

The sanitation service standards have set by Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (2016-2030). It classifies sanitation services as high, medium, and basic based on sanitation facilities in place. The sanitation service levels with indicators are shown in Table 5. However, FSM specific standards have yet to be developed and implemented.

Table 5: Sanitation Service Level and its Components.

S.N.	Service Components	Service Level		
		High	Medium	Basic
1	Health and Hygiene Education	✓	✓	✓
2	Household Latrine	✓	✓	✓
3	Public and School Toilets	✓	✓	✓
4	Septic tank sludge collection, transport, treatment, and disposal	✓	✓	✓
5	Surface drains for collection, transmission, and disposal of grey water	✓	✓	✓
6	Small-bore sewer collection for toilet and septic tank effluent, low-cost treatment, and disposal		✓	
7	Sanitary sewers for wastewater collection, transmission, non-conventional treatment, and disposal	✓		
8	Sanitary sewers for wastewater collection, the transmission of conventional treatment and disposal	✓		
9	Limited solid waste collection and safe disposal	✓	✓	✓

4. Stakeholder Engagement

4.1 Key Informant Interviews

During the study, Key Informant Interviews (KIIs) were conducted to gather valuable insights from key stakeholders in the sanitation sector of Shivaraj Municipality. The objective of these interviews was to gain a comprehensive understanding of the current sanitation service practices. Specifically, Mr. Rajesh Chaudhary, the WASH Focal person of Shivaraj Municipality, was interviewed to gather insights into the municipality's sanitation service practices, considering technical, institutional, and financial aspects. Another interview was conducted with Mr. Nandalal Kurmi, the chairperson of Shivgadhi WSUC, and Mr. Hariram Chaudhary, a plumber of Chandrauta WSUC in Ward 5. Furthermore, Kamal Prasad Sapkota and Arjun Belbase, private desludgers involved in desludging services, were interviewed to gain insights into faecal sludge emptying and disposal practices. The discussions covered topics such as types of containments, containment volumes, and the frequency of emptying.

Table 6 provides a list of the KIIs conducted, including the names of the individuals interviewed and their respective designations within their affiliated organizations.

Table 6: List of Key Informant Interviews conducted to personnel.

S.N.	Name	Designation	Organization	Purpose of KII
1	Mr. Rajesh Kurmi Chaudhary (KII-1)	WASH Focal person	Shivaraj Municipality	Sanitation status, Ongoing projects on Sanitation, Policies and plan for Sanitation development
2	Mr. Nanda Lal Kurmi (KII-2)	CHairperson	Shivgadhi WSUC	Water Supply Services
3	Mr. Hari Ram Chaudhary (KII-3)	Plumber/ Caretaker	Chandrauta WSUC	Water Supply Services
4	Mr. Kamal Prasad Sapkota (KII-4)	Proprietor, Lumbini Traders	Private Desludger,	Status of Desludging within municipality
5	Mr. Arjun Belbase (KII-5)	Proprietor, Shivraj Sanitary	Private Desludger,	Status of Desludging within municipality

4.2 Household Questionnaire Survey

Household survey was conducted in all wards of the municipality through mobilization of enumerators selected by the municipality. The enumerators were given two days orientation about sanitation and methods for conducting HH survey. The household survey was conducted using mobile application “KOBOCOLLECT” after orientation. SFD team members went on field visit in households to encourage enumerators and observe household sanitation status.

4.2.1 Determining Sample Size

The number of households to be sampled in the municipality was determined by using Cochran (1963:75) sample size formula $no = \frac{z2pq}{e2}$ and its finite population correction for the proportion $n = n_o/(1 + (n_o - 1)/N)$. Where,

Z	1.96	At the confidence level of 95%
p	0.5	Assuming that about 50% of the population should have some sanitation characteristics that need to be studied (this was set at 50% since this percentage would yield the maximum sample size as the percentage of the population practising some form of sanitation is not known at the intervention sites).
q	1-p	
e	+/-5%	Level of precision or sampling error.
N		A total number of population (households in the municipality).

This is followed by proportionate stratification random sampling such that each ward in the municipality is considered as one stratum. The sample sized required in each ward is calculated as $n_h = (N_h/N)*n$, where N_h is a total population in each stratum.

Thus, a total of 375 households were sampled from 16,241 households distributed in 11 wards with proportionate stratification random sampling which is shown in Figure 19.

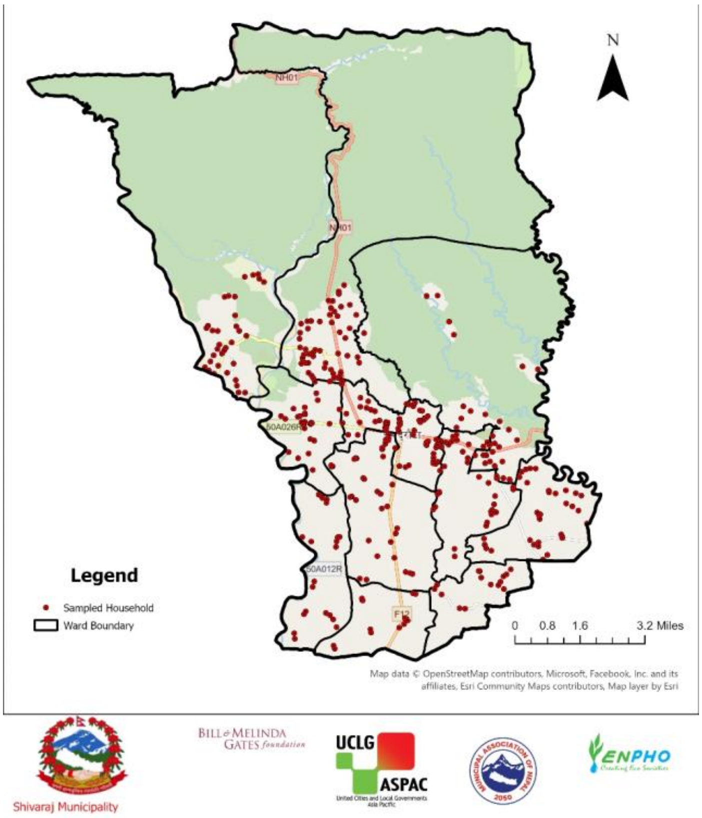

Figure 19: Distribution of sampling points in different wards Shivaraj Municipality.

4.3 Direct Observation

Various sources of drinking water and containments in the households in all the wards were observed and visual references were kept. Also, observation of the private desludging vehicles was done by meeting the operator and entrepreneur of private desludging vehicles.

4.4 Sharing and Validation of Data

The SFD sharing and validation workshop was conducted in the municipality on date 6th December, 2023 to share the finding of the sanitation situation survey and receive the suggestion from municipal stakeholders. Altogether, 31 participants including the mayor, CAO, ward chairpersons and other members from municipal executive council, sectoral staffs etc. actively participated on the workshop and provided the valuable suggestions. The list of participants with their designation is attached in Appendix 1.

5. Acknowledgements

We would like to acknowledge the organizations involved in the Municipalities Advocacy on Sanitation in South Asia – II (MuNASS-II) project for their collaboration and coordination, namely the United Cities Local Government – Asia Pacific (UCLG ASPAC) as the executing agency and the Municipal Association of Nepal (MuAN) as the implementing agency, for their coordination with the municipality.

We extend our sincere appreciation to the individuals who provided invaluable support and guidance during the study: Mr. Ajay Thapa, the Mayor; Mr. Shiva Kumari Chaudhary, the Deputy Mayor; and Mr. Rajesh Chaudhary, the WASH Focal Person of Shivaraj municipality, Mr. Dilli Raj Bhattarai. We are also thankful to the ward chairpersons and the entire municipal staff for their valuable support.

We would like appreciate Dr. Roshan Raj Shrestha, Deputy Director of Bill and Melinda Gates Foundation (BMGF), Mr. Ashok Kumar Byanju Shrestha, Former President, UCLG ASPAC, Dr. Bernadia Irawati Tjandradewi, Secretary General, UCLG ASPAC and Mr. Satish Jung Shah, Knowledge Management Officer, UCLG ASPAC. Similarly, we are very much obliged to Mr. Bhim Prasad Dhungana, President, MUAN and Co. President, UCLG ASPAC, Mr. Kalanidhi Devkota, Executive Director, MUAN Mr. Muskan Shrestha, Sanitation Advocacy Specialist, MuAN for their gracious support during the study.

Our heartfelt appreciation also goes to Ms. Bhawana Sharma, Executive Director, and Mr. Rajendra Shrestha, Program Director of Environment and Public Health Organization (ENPHO) for their tremendous support and guidance throughout the study. We are grateful to the entire ENPHO team for their gracious support, as well as the MuNASS-II team, without whom this study would not have been possible.

Finally, we extend our thanks to the enumerators: Ms. Bindu Chaudhary, Ms. Arati Aryal, Mr. Navaraj Khadka, Mr. Gulame Gaus Khan, Mr. Uttam Chaudhary, Mr. Ramesh Chaudhary, Mr. Madan Khanal, and Mr. Ram Prasad Pasi, for their support during the survey.

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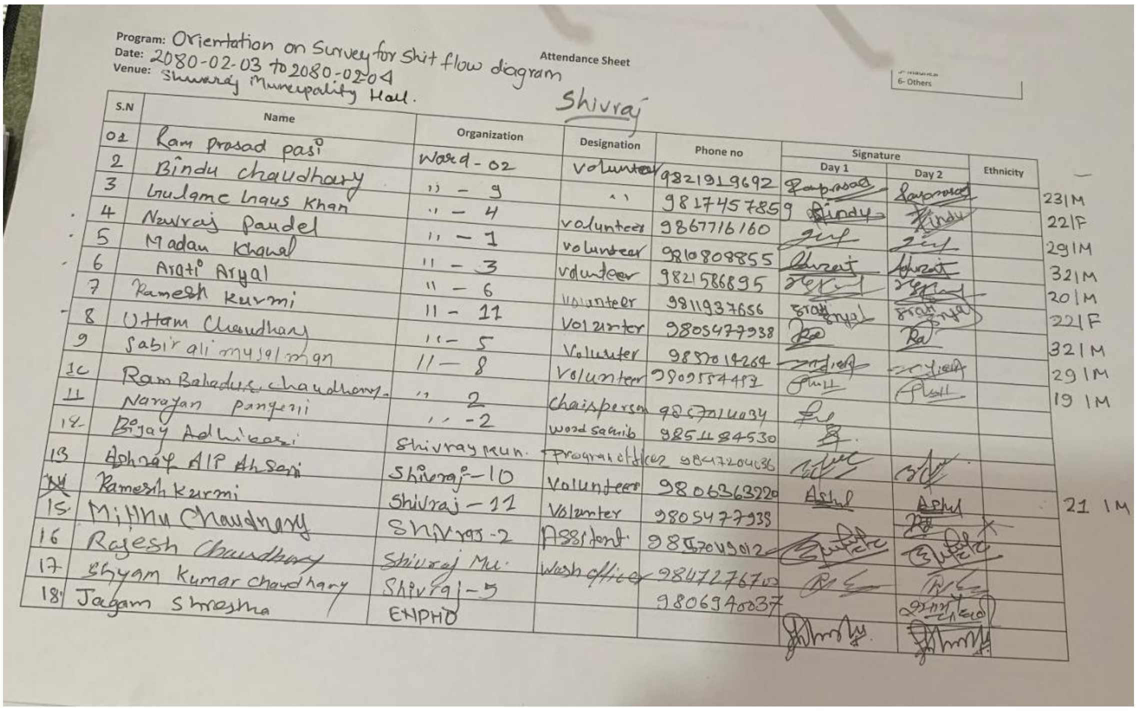
7 Appendix

7.1 Appendix 1: Roles and Responsibility of Various Tiers of Governments Delineated in Drafted SDP 2016 – 2030

System Classification		**Minimum Key HR Required**	**Regulation & Surveillance**	**Financing & Construction**	**Ownership of System**	**Service Delivery**	
Size	Sanitation					Provision	Production
Small	Onsite sanitation	Water Supply and Sanitation Technician (WSST)	Federal and or Provincial Government	User+/ community+/ other			
Medium	Septage Management	Sub-engineer	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Users committee/ Utility manager
Large	Septage or FSM Management	WASH Engineer + finance & admin staff	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Utility Manager
Mega	Septage/ FSM Management	WASH Engineer + finance & admin staff	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Utility Manager

7.2 Appendix 2: List of participants on orientation on survey for SFD



Program: Orientation on Survey for Shit flow diagram

Date: 2080-02-03 to 2080-02-04

Venue: Shivraj Municipality Hall.

Attendance Sheet

Shivraj

6- Others

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity	
01	Ram Prasad pasi	Ward-02	volunteer	9821919692				23|M
2	Bindu chaudhary	〃 - 9	〃	9817457859				22|F
3	Gulame Gaus Khan	〃 - 4	volunteer	9867716160				29|M
4	Nawraj Paudel	〃 - 1	volunteer	9810808855				32|M
5	Madan Khanal	〃 - 3	volunteer	9821586895				20|M
6	Arati Aryal	〃 - 6	volunteer	9811937656				22|F
7	Ramesh Kurmi	〃 - 11	Volunter	9805477938				32|M
8	Uttam Chaudhary	〃 - 5	Volunter	9837014264				29|M
9	Sabir ali musalman	〃 - 8	Volunteer	9809554487				19 |M
10	Ram Bahadur chaudhary	〃 2	Chairperson	9857014034				
11	Narayan Pangeni	〃 - 2	ward samiti	9854484530				
12	Bijay Adhikari	Shivraj mun.	Program officer	9847204036				
13	Ashraf Ali Ansari	Shivraj-10	Volunteer	9806363220				21 |M
14	Ramesh Kurmi	Shivraj-11	Volunter	9805477935				
15	Mithu Chaudhary	Shivraj-2	Assistant	9857049012				
16	Rajesh Chaudhary	Shivraj Mu.	Wash officer	9847276700				
17	Shyam Kumar chaudhary	Shivraj-5		9806940037				
18	Jagam Shrestha	ENPHO						

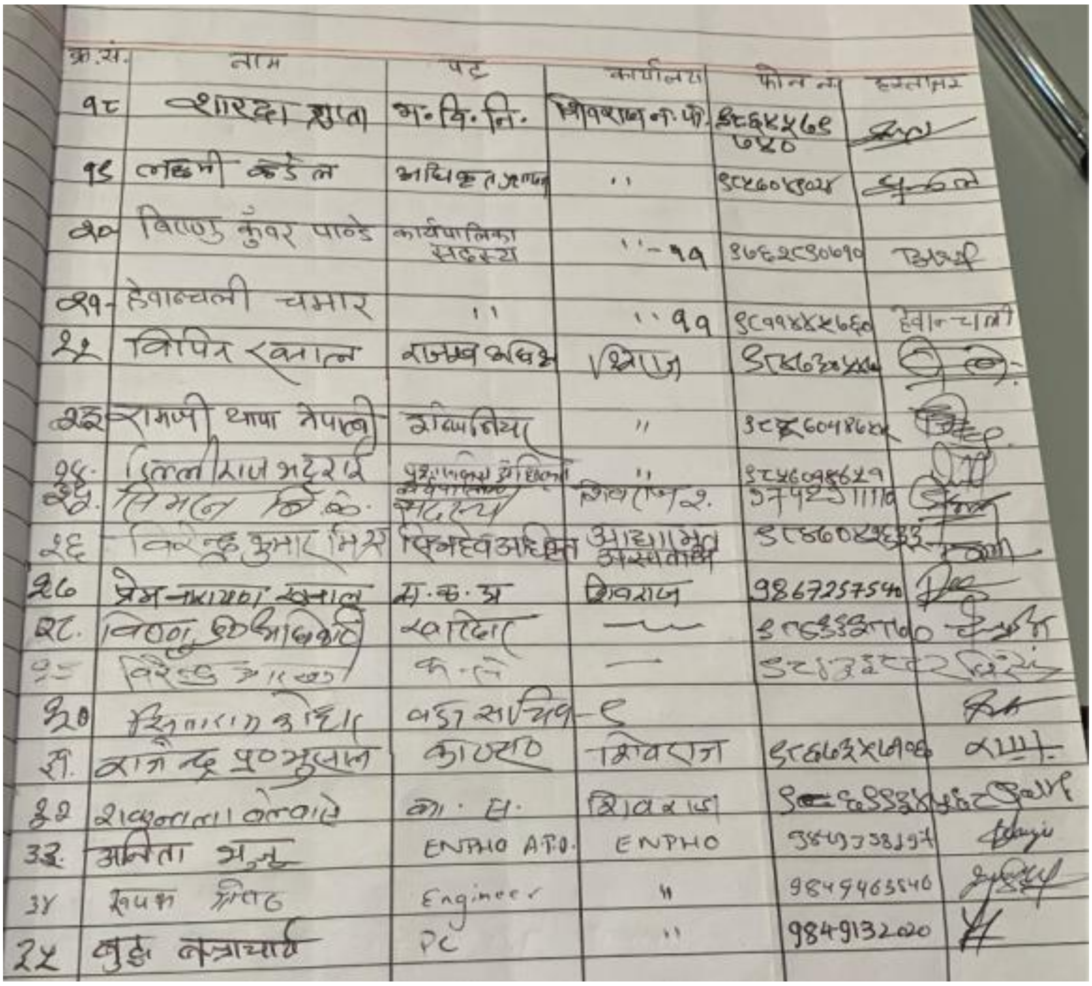
7.3 Appendix 3: SFD orientation to enumerators for household and institutional survey

7.4 Appendix 4: Attendance sheet of sharing and validation workshop

आज मिति २०८० साल मंसिर २० गतेका दिन शिवराज नगरपालिकामा नेपाल नगरपालिका संघको आयोजनामा वातावरण र जनस्वास्थ्य संस्था (एन्फो) को प्राविधिक सहयोग, The United Cities and Local Government Asia Pacific (UCLG ASPAC) को सहकार्यमा र Bill and Melinda Gates Foundation (BMGF) को आर्थिक सहयोगमा मानव मलमुत्र प्रवाह रेखाचित्र (Shit Flow Diagram- SFD) सम्बन्धि छलफल तथा प्रमाणीकरण कार्यक्रममा निम्न अनुसार सरोकारवालाहरूको उपस्थिति रहेको छ ।

उपस्थिति :

क्र.सं.	नाम	पद	कार्यालय	फोन नं.	हस्ताक्षर
१.	अजय थापा	नगर प्रमुख	शिवराज नगरपालिका	९८५७०५५००४	
२.	शिव कुमारी थारू	नगर उप-प्रमुख	शिवराज नगरपालिका	९८५७०९४५३६	
३.	बाबु राम पौडेल	प्र. प्र. अ.	शिवराज नगरपालिका	९८५७०८६१११	
४.	माहेताबआलम खाँ	वडा अध्यक्ष	शिवराज - ६	९८५६०९८४५६	
५.	नसीम अहमद खाँ	वडा अध्यक्ष	शिवराज ४	९८५६०९४५६८	
६	तारा चन्द्र चौधरी	कृ. वि. अ.	शिवराज नगरपालिका	९८८६०९४७०६	
7	सन्त कुमार थारु	कार्यपालिका सदस्य	शिवराज	9811571954	सन्तकुमार
8	रिजवान अहमद	वडा अध्यक्ष	शिवराज न.पा. 8	9819423977	
९	राम बहादुर चौधरी	वडाध्यक्ष	शिवराज - 2	9857014034	
१०	श्याम लाल थारु	का.वा. वडाध्यक्ष	शिवराज - 3	9847042783	
११	राम गोपाल चौधरी	वडा अध्यक्ष	शिवराज - ५	९८५६०५३६२२	
१२	कु बसन्ती दुगराज	वडा सदस्य	शिवराज - १	९८४६०६३५६४	
१३	[illegible]	वडा अध्यक्ष	शिवराज १०	९८०७८८९१८८	
१४.	अनुप कुमार चौधरी	वडा अध्यक्ष	शिवराज न. पा. ६	९८५६०५५३२९	
१५	रमेश्वर प्र. वर्मा	वडाध्यक्ष	" - ११	९८४६२०४८३४	
१६	चुडामणि भट्टराई	स्वा. शाखा प्रमुख	शिवराज न.पा.	९८५११८०६६५	
१७	इतेवार रवताल	प. वि. अ.	पशु सेवा शाखा	९८४०२८०६८१	



क्र.सं.	नाम	पद	कार्यालय	फोन नं.	हस्ताक्षर
१८	शारदा गुप्ता	भ.वि.नि.	शिवराज न.पा.	[illegible]	[illegible]
१९	लक्ष्मी कँडेल	अधिकृत [illegible]	"	[illegible]	[illegible]
२०	विष्णु कुँवर पाण्डे	कार्यपालिका सदस्य	"-११	[illegible]	[illegible]
२१	हेवान्चली चमार	"	"११	[illegible]	हेवान चमार
२२	विपिन खनाल	राजस्व अधिकृत	शिवराज	[illegible]	[illegible]
२३	रामजी थापा नेपाली	[illegible]	"	[illegible]	[illegible]
२४	[illegible] राज भट्टराई	प्रशासकीय अधिकृत	"	[illegible]	[illegible]
२५	[illegible]	कार्यपालिका सदस्य	शिवराज-२	[illegible]	[illegible]
२६	विरेन्द्र कुमार मिश्र	[illegible] अधिकृत	आधारभूत अस्पताल	[illegible]	[illegible]
२७	प्रेम नारायण खनाल	प्र.क.अ	शिवराज	9867257540	[illegible]
२८	विष्णु [illegible] अधिकारी	खरिदार	—	[illegible]	[illegible]
२९	विरेन्द्र [illegible]	क.ले	—	[illegible]	[illegible]
३०	[illegible]	वडा सचिव-९			[illegible]
३१	राजेन्द्र प्र. भुसाल	का.स.	शिवराज	[illegible]	[illegible]
३२	शकुन्तला [illegible]	का.स.	शिवराज	[illegible]	[illegible]
३३	अनिता [illegible]	ENPHO A.P.O.	ENPHO	[illegible]	[illegible]
३४	रुपक श्रेष्ठ	Engineer	"	9849463540	[illegible]
३५	बुद्ध वज्राचार्य	PC	"	9849132020	[illegible]

7.5 Appendix 5: Glimpses of Validation Workshop

7.6 Appendix 6: Glimpses of KIIs

KII with Private Desludger

KII in Chandrauta WSUC

7.7 Appendix 7: Water Quality Test Report

WSUC	Total Sample (handpump)	Sample taken for E.coli test	Presence of E. coli	Depth (E.coli number)
Uday Tole Handpump WSUC	15	4	2	55ft (4 CFU/100ml) 17ft (6 CFU/100ml)
Ojawa handpump WSUC	39	7	7	20ft (36 CFU/100ml) 23ft(63 CFU/100ml) 28ft(12 CFU/100ml) 30ft (5 CFU/100ml) 35ft (45 CFU/100ml) 145 ft (16 CFU/100ml) 180ft (5 CFU/100ml)
Harhawa handpump WSUC	41	8	3	35 ft (6 CFU/100ml) 35ft (8 CFU/100ml) 140ft (>100 CFU/100ml)
Milan chowk Handpump WSUC	50	10	9	25ft (36 CFU/100ml) 35ft (>100 CFU/100ml) 35ft (8 CFU/100ml) 40ft (4 CFU/100ml) 45ft (6 CFU/100ml) 45ft (8 CFU/100ml) 45ft (4 CFU/100ml) 125ft (36 CFU/100ml) 138ft (9 CFU/100ml)
Harhatti WSUC	21	6	6	35ft (29 CFU/100ml) 52ft (38 CFU/100ml) 110ft (>100 CFU/100ml) 125ft (25 CFU/100ml) 150ft (<100 CFU/100ml) 160ft (32 CFU/100ml)
Madrahawa WSUC	56	15	0	
Total	222	50	27	

Source: Shivaraj Municipality, Environment Section

SFD Shivaraj Municipality, Nepal, 2024

Produced by:

Asmita Shrestha, ENPHO

Jagam Shrestha, ENPHO

Buddha Bajracharya, ENPHO

Rupak Shrestha, ENPHO

Anita Bhuju, ENPHO

Sabuna Gamal, ENPHO

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SFD Promotion Initiative